

## **Slow-Flow Volume-Pressure Curve: Assessment for Lower Inflection Point**

### **Purpose:**

To describe the procedure to be followed when adjusting ventilator parameters to produce a volume-pressure curve to assess optimum PEEP in relation to a lower inflection point (LIP).

### **Description:**

Static volume-pressure curves have proven useful in assessing changes in lung compliance throughout the length of the curve. A lung protective strategy of ventilation can be proposed by identifying a LIP, the critical opening pressure of collapsed alveoli, and an upper inflection point (UIP), the point of lung overinflation. With PEEP set about 2 cmH<sub>2</sub>O above the LIP, and P<sub>plateau</sub> set below the UIP, the lung can be protected from shear forces associated with repeated recruitment and de-recruitment of collapsed alveoli and from damage due to overinflation of open alveoli.

Volume-pressure curves can be produced at the bedside on the ventilator graphics monitor, however, they are a “dynamic” curve and will be affected by the resistive properties of the respiratory system. To minimize these resistive effects, and mimic a “static” curve, a very low constant inspiratory flow must be used during the assessment.

### **Indications:**

1. The need to determine optimum PEEP and maximum P<sub>plateau</sub>, to be used in a lung protective ventilation strategy.
2. The need to assess the “near static” compliance properties of the respiratory system.

### **Contraindications/Hazards/Complications:**

1. Removing PEEP for the short time required to perform the 2 to 3 breath maneuver may cause further de-recruitment. May cause alveolar flooding in the presence of pulmonary edema or hemorrhage. Patients with hemodynamic compromise (low blood pressure, volume depletion, poor cardiac function) may not tolerate the associated changes in ventilator parameters.
2. Increased inspiratory resistance or the presence of Auto-PEEP may cause artifact affecting accuracy.
3. Improper technique, or incorrect interpretation of results, may lead to inappropriate decision in ventilator management.
4. The risks/benefits should be carefully considered before performing maneuver.

### **Equipment:**

1. Mechanical ventilator capable of producing an inspiratory flow  $\leq$  6 Lpm in a constant flow pattern.
2. Ventilator graphics monitor capable of displaying a volume-pressure loop.
3. Printer function is not necessary, but is of benefit to produce a hard copy of the curve for evaluation and documentation.

**Personnel:** The respiratory therapist shall perform the maneuver upon request of the patient’s physician. Interpretation will involve consultation between the respiratory therapist and the attending physician or critical care fellow.

Procedure:

Preparation

1. Physician order is required to initiate the procedure.
2. Passive inspiration is required, therefore, the patient must have cessation of spontaneous respiratory efforts (pharmacological paralysis or sedation).
3. Empty water traps, assess for need to suction, attempt to relieve any bronchospasm if wheezing, to ensure accurate results.
4. If inexperienced in the procedure, call the Lead Therapist, ICU Specialist, Supervisor or Coordinator for assistance.

Technique

1. Prepare graphics monitor to display the volume-pressure loop with appropriate scale. If printer is to be utilized, ensure proper function.
2. Hyperoxygenate patient with 100%.
3. Remove any inspiratory rise time or slope.
4. Change to VC mode with appropriate tidal volume.
5. Decrease RR to minimum. (RR 5 on the Siemens 300. Adjust tidal volume with RR changes).
6. Decrease PEEP to zero.
7. Reduce inspiratory flow to minimum ( $\leq 6$  Lpm for best results). (On the Siemens 300 this is accomplished by increasing Insp time to 80% and adjusting tidal volume.
8. Observe 2 to 3 breaths for accuracy and freeze screen for interpretation. Print screen. If printer is not available, have physician view the screen at bedside.
9. Return ventilator parameters to initial settings ASAP, decreasing Insp time and increasing PEEP **first**.

**NOTE:** Steps 4 through 9 must be performed quickly to decrease the amount of time the patient is subject to these parameters.

10. Consult with physician for interpretation of results. Document the procedure in the ventilator progress notes. Example: "Performed slow-flow volume-pressure curve. Patient tolerated procedure well with hyperoxygenation. SpO<sub>2</sub> remained 98%. Dr Grier agrees that LIP is apparent at +12 cmH<sub>2</sub>O. PEEP thus increased to +14 cmH<sub>2</sub>O." (Written physician order required if PEEP is changed).
11. Charge for lung mechanics on the Master Sheets.

Infection Control: Maintain standard universal precautions.

References:

Amato MBP. "Effect of a protective-ventilation strategy on mortality in the acute respiratory distress syndrome." N Engl J Med 1998;338(6):347-354

Qin Lu. "A simple automated method for measuring pressure-volume curves during mechanical ventilation." Am J Respir Crit Care Med 1999;159:275-282

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